GRAITEC MODELING THE FUTURE

How to use Towers

An introduction to the basics of the Towers macro

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1 TRANSMISSION TOWER – INTRODUCTION

This guide is to be used in conjunction with the main product help, this guide aims to help the user to get started with using the towers macro and experiment with some of the settings and options.

1.1 BASIS OF SAMPLE MODEL

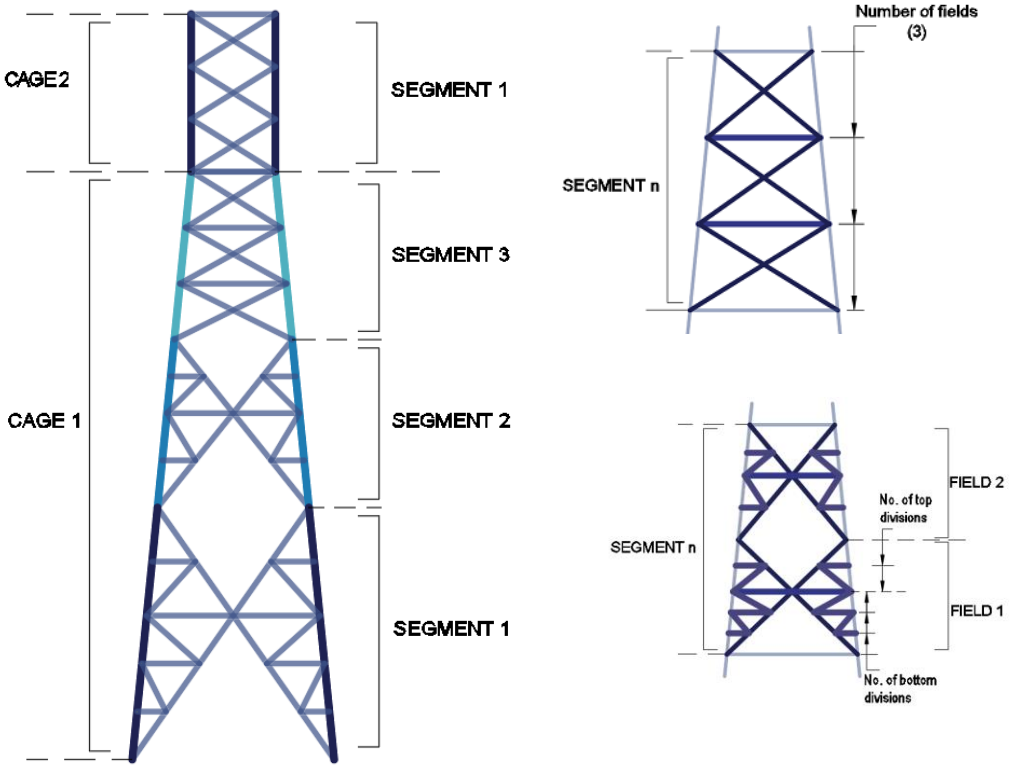
For this guide we will reference a sample model, this model is a generic arrangement created for this walkthrough of how the tower macro can be used, in the course of the guide we explore the settings for the different elements and understand the application within the context of the tower framework.

1.1.1 The terminology used for Towers macro

The tower body is composed of a user-defined number of **cages.**

A cage is a main part of the tower body (inclined, or straight), divided into a series of segments (see pictures below).

Please find brief definitions of the main terminology used throughout the macro below:



Cages: Main parts of the tower body which have different slopes.

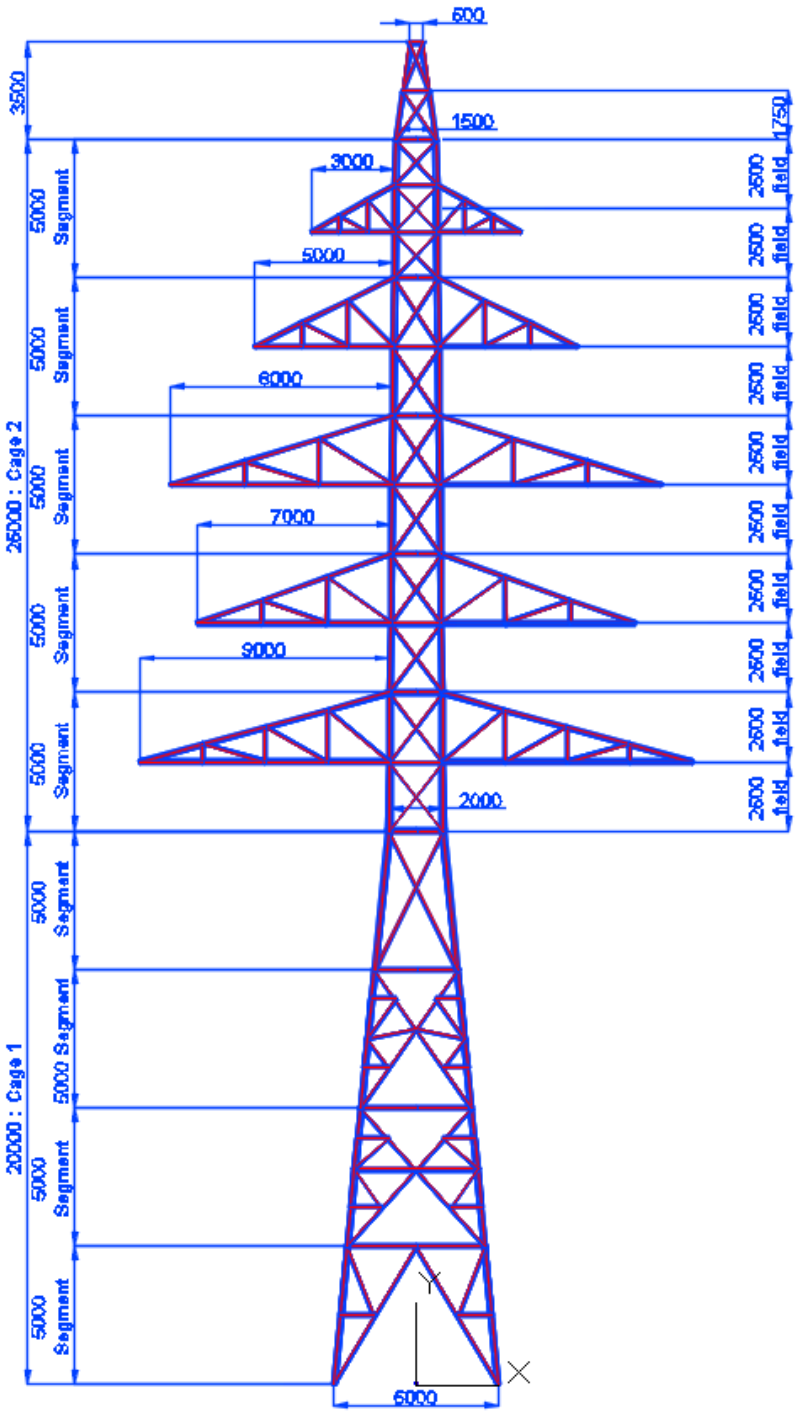
Segments: Cage divisions. The number of segments of a cage is equal to the number of leg divisions.

Fields: Equal segment divisions made by the selected bracing system.

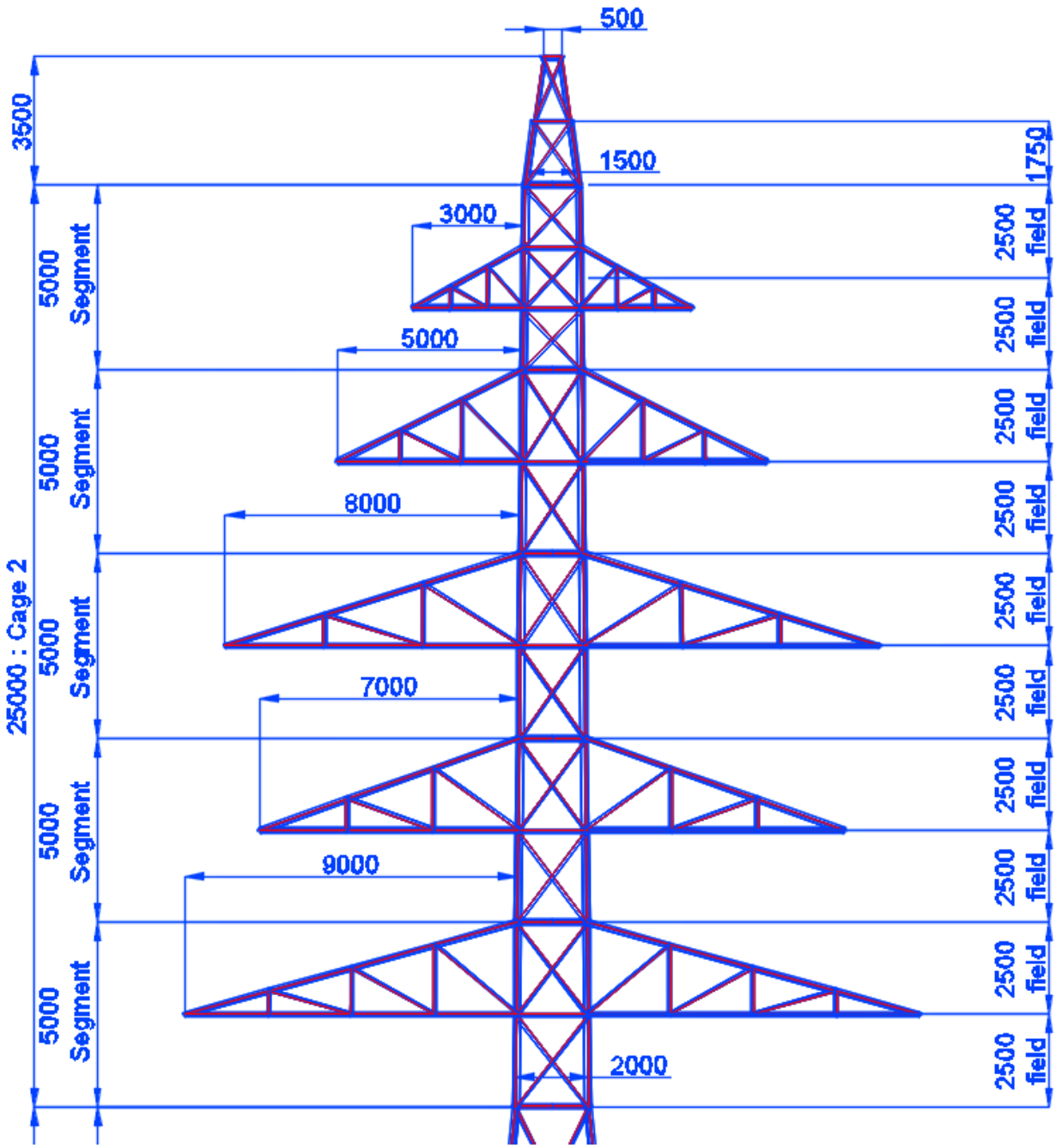
Divisions: Equal parts of a field made by the web bracings (above and below the horizontal) – for XBS and KS type of vertical bracings.

1.1.2 Tower Model reference dimensions

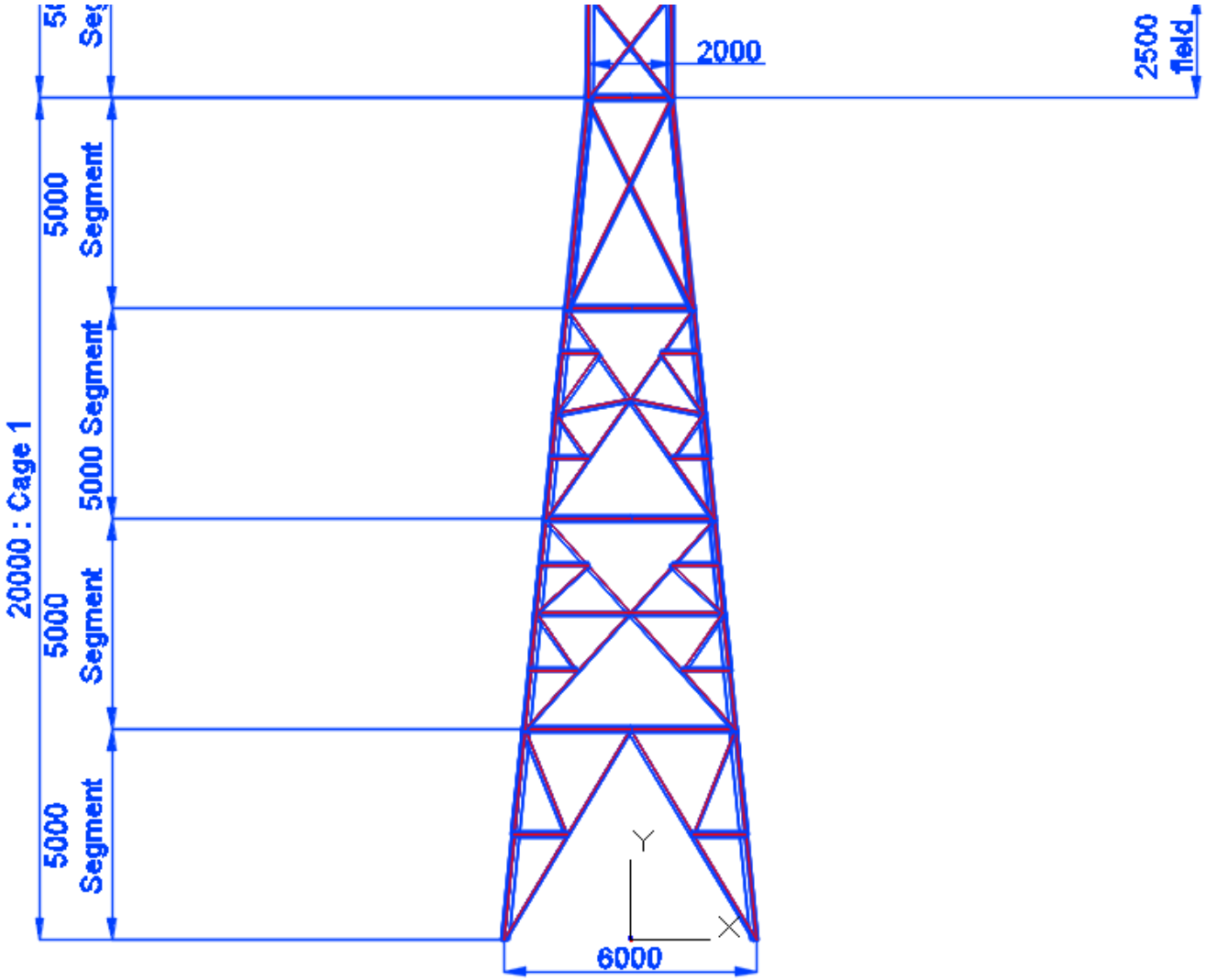
For this guide, the model created will refer to the reference arrangement and dimensions as shown in the images below:



Upper Cage (2)


500
3500
1500
1750
3000
2500 field
5000
5000 Segment
5000
8000
7000
9000
2000
25000 : Cage 2

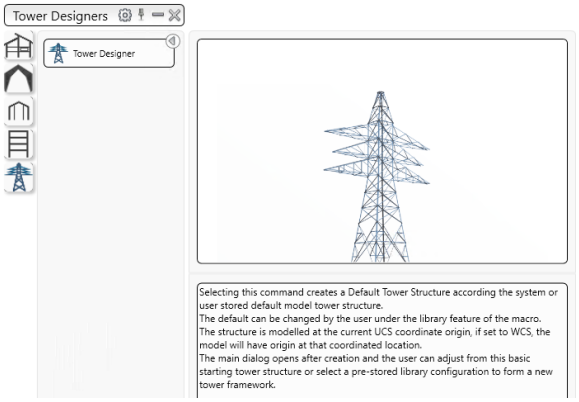
Lower Cage (1)


2000
2500
field
5000
Segment
5000 Segment
5000
Segment
5000
Segment
20000 : Cage 1
Y
X
6000

2 STARTING THE MACRO

The towers command is located under the **Structures palette**, with a **specific tab** for **Towers Designers**, select this, and then the **Command button** and the **towers designer command** will start. The creation of the tower is based upon the Current UCS 0,0,0 location, typically a user would start at WCS.

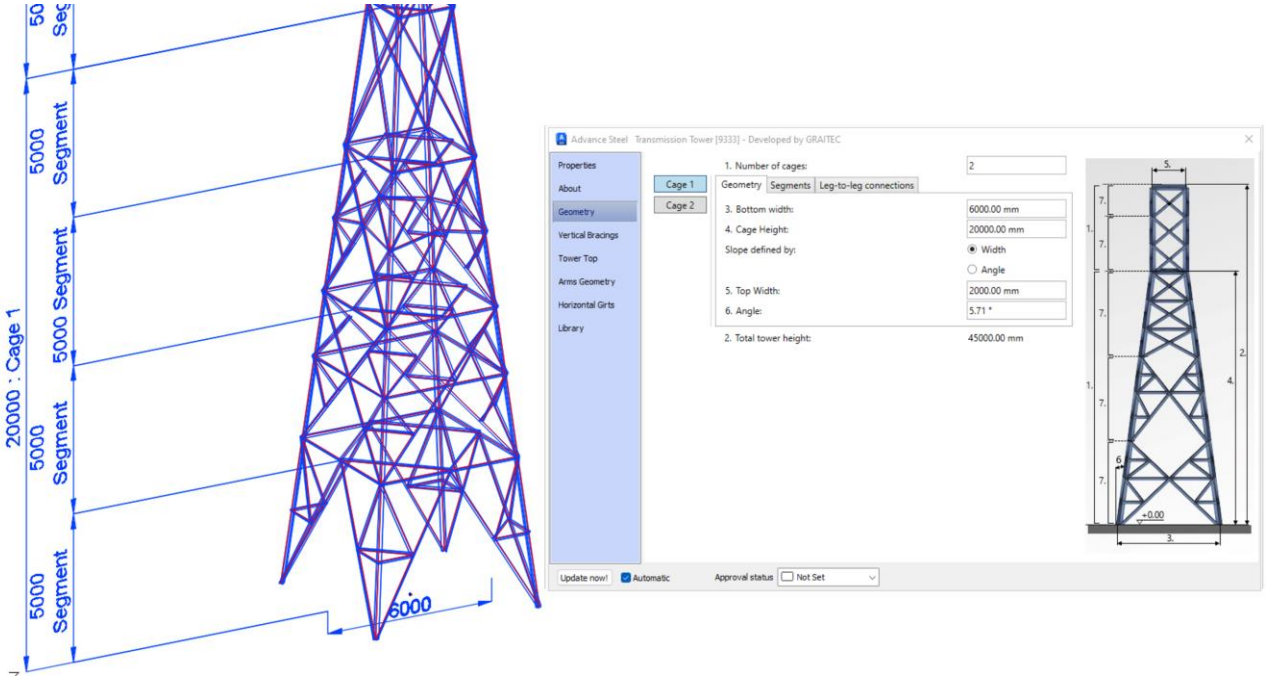
For this example, we will use WCS (0,0,0)



The tower is made from cage elements, segments, and then fields, let's start with the lower cage (1)

2.1 CAGE 1 DEFINITION

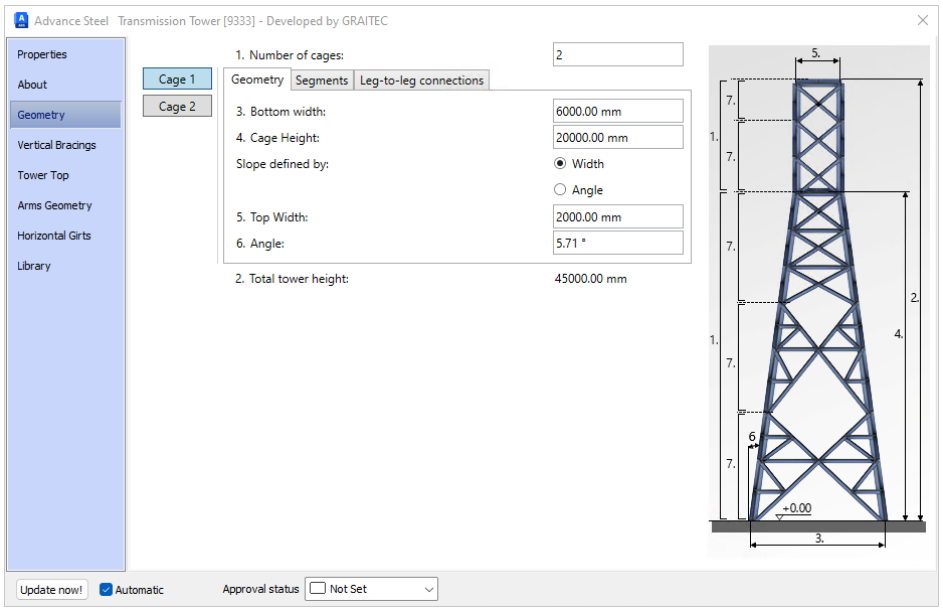
Once the macro is open, browse to the Geometry Tab and then select the Cage 1 command button, this will place the corresponding tabs into that cage element of the tower.



2.1.1 Cage 1: Geometry Tab >Cage 1 > Geometry sub tab

Under cage 1, sub geometry tab, we are going adjust the bottom width and top width, and cage height.

- **3.bottom width:** set to 6000mm.
- **4. cage height:** set to 20000mm.
- **5.top width:** set to 2000mm.

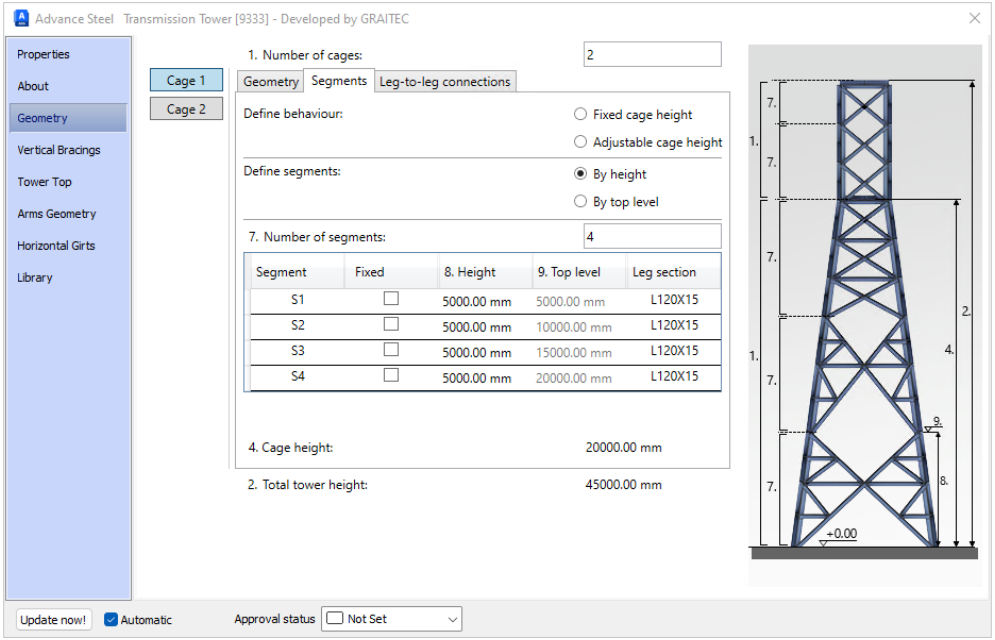


Note*: Leave remaining parameters as set.*

2.1.2 Cage 1: Geometry Tab >Cage 1 > Segments sub tab

Changing to this sub tab, Segments, we can increase the number 4 levels,

- **7.Number of Segments:** set to 4 no.



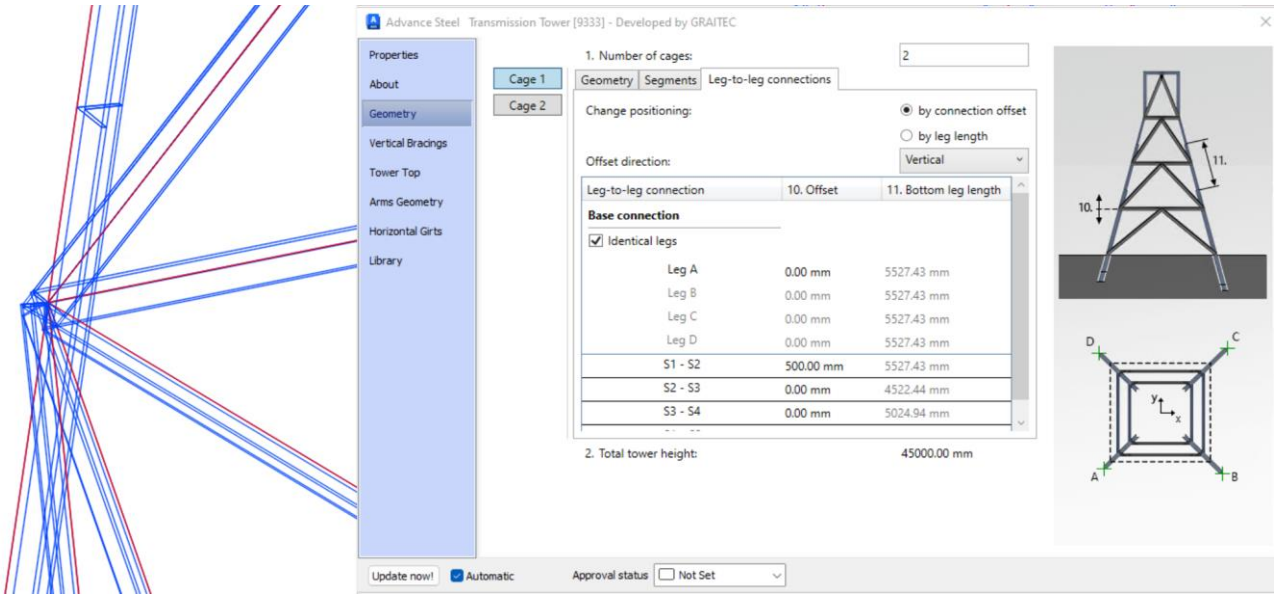
Note: *The table below increases to add this segment.*

2.1.3 Cage 1: Leg-to-leg connections

For this sub tab, we are going to introduce an offset in the vertical direction of 500mm.

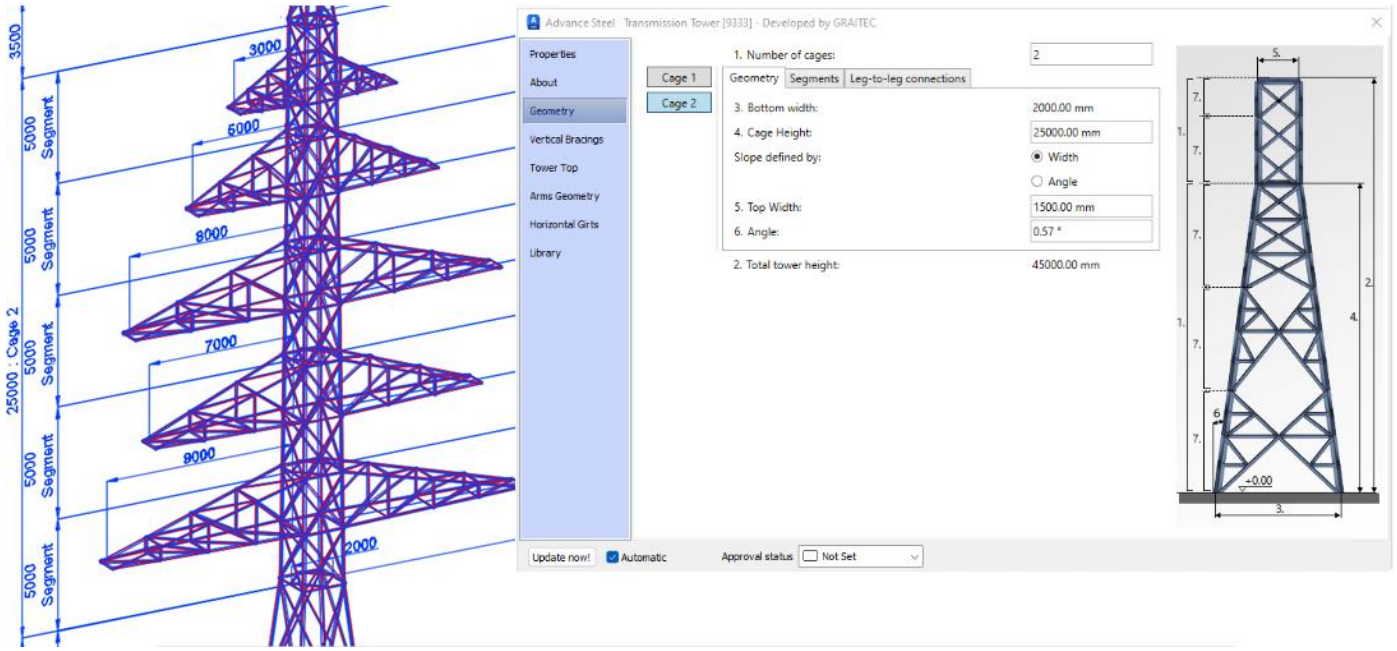
- In the table, **adjust** the **S1-S2 value** to **500mm**.

Note: *the lower leg will be increased in length along the compound incline pitch of the tower legs.*



2.2 CAGE 2

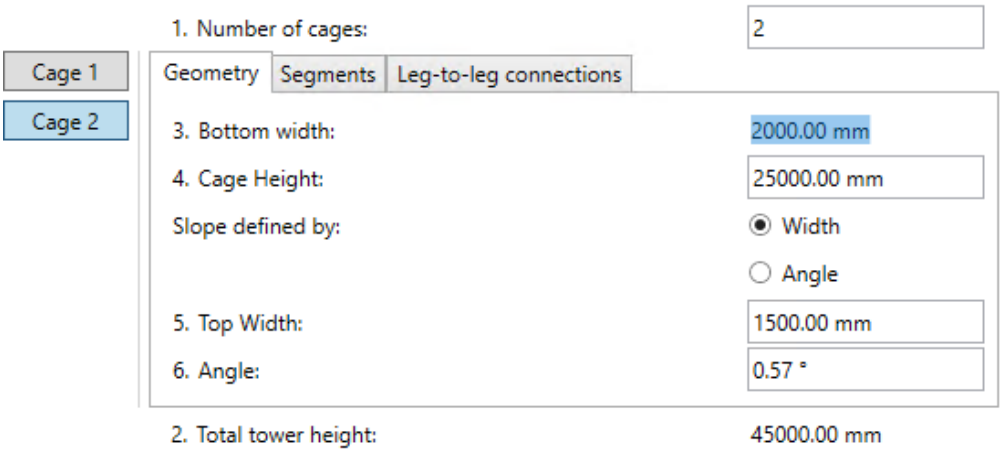
To move to Cage 2, select the Cage 2 button, the sub tabs of Geometry, Segments, and Leg to Leg are now working within that cage.



2.2.1 Cage 2: Geometry Sub tab

Under the first sub-tab, Geometry, change the cage height and the top width of the cage to alter the arrangement.

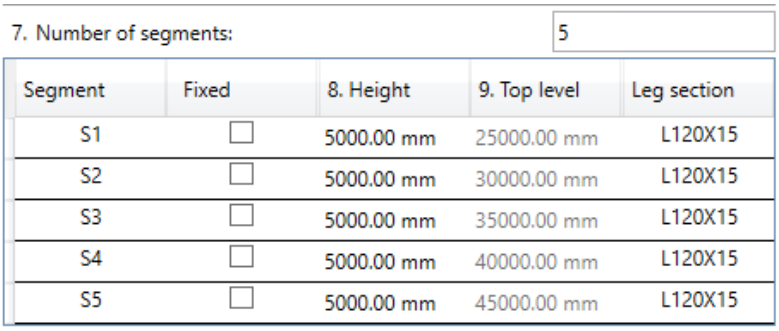
- **4.cage height:** Set to 25000mm.
- **5.Top width:** set to 1500mm.



2.2.2 Cage 2: Segment tab

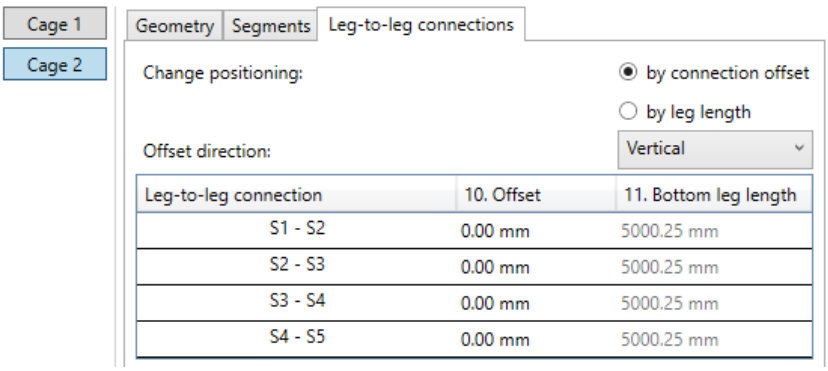
For this sub-tab, we are going to increase the number of segments to 5 no.

- **7.Number of Segments:** set to 5. (The table below will populate with the extra segments)



2.2.3 Leg to leg tab

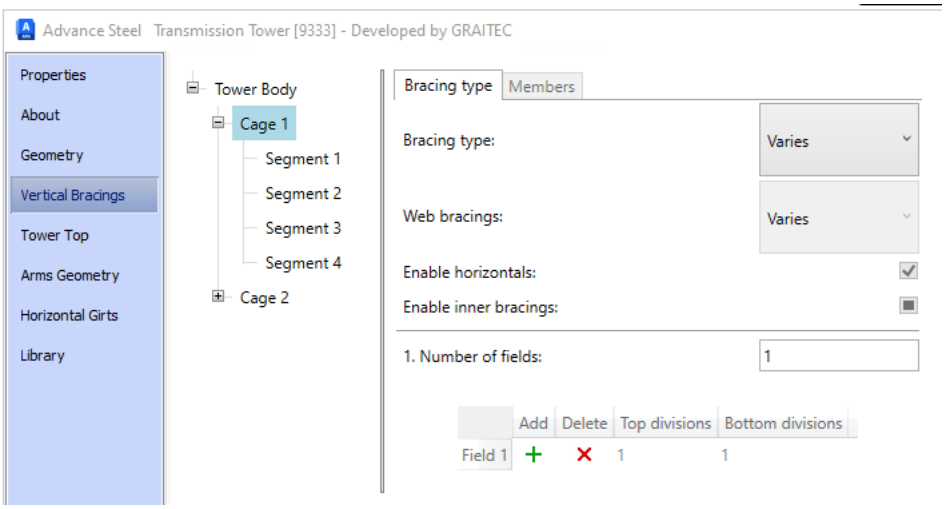
Within this example we make no changes, to move the main leg start and ends.



3 VERTICAL BRACINGS

Changing the macro to the Vertical Bracing tab, we can now explore how to add bracing configs of different types and highlight some of the options.

First step is to expand the Magic Tree of the dialog to see the segments, as with other macros from Graitec, applying at the top level of the magic tree apply those settings down into all the sub-branches.



For this example, we are going to work per segment in each of the two (2) Cages to set a series of different types of bracing, for example, purposes.

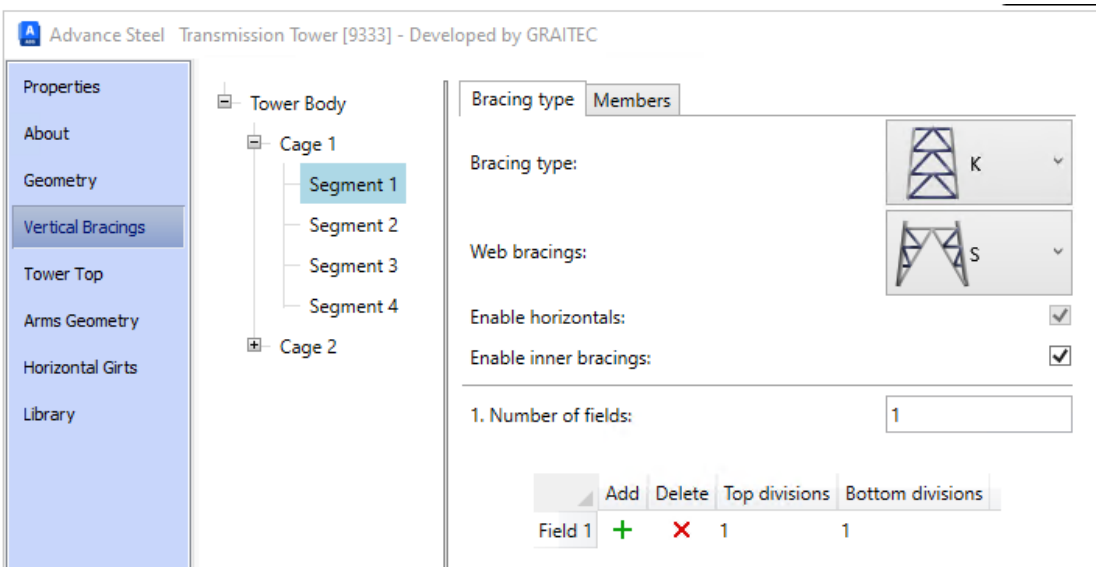
3.1 CAGE 1

Previously we set Cage 1 of the tower to have Four (4) segments, therefore for this example, we can configure these as one type or as different types, if all the vertical bracings are required the same, then select **Cage 1** level of the magic tree.

For this example, we will explore setting them differently within each segment to show some of the different options available to the user.

3.1.1 Cage 1> Segment 1.

To access the Cage 1> Segment 1, select the relative sub-branch of the tree, this then enables the panel tabs to be relative to that level of the macro branching.



3.1.1.1 Sub-Tab: Bracing Type

Under this tab, change the following:

Combo selector: set to **Type K.**

3.1.1.2 Sub-Tab: Web Bracing

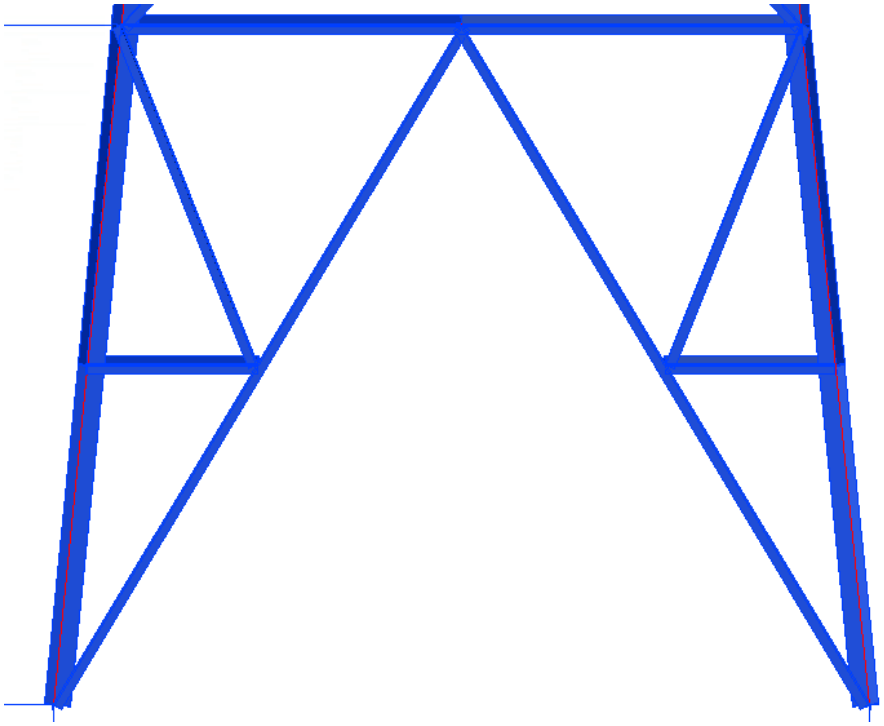
Under this tab, change the following:

Combo selector: set to **Type S.**

3.1.1.3 Check box: Enable horizontals

Check this box to introduce the internal diagonal between the K bracing across the tower faces.

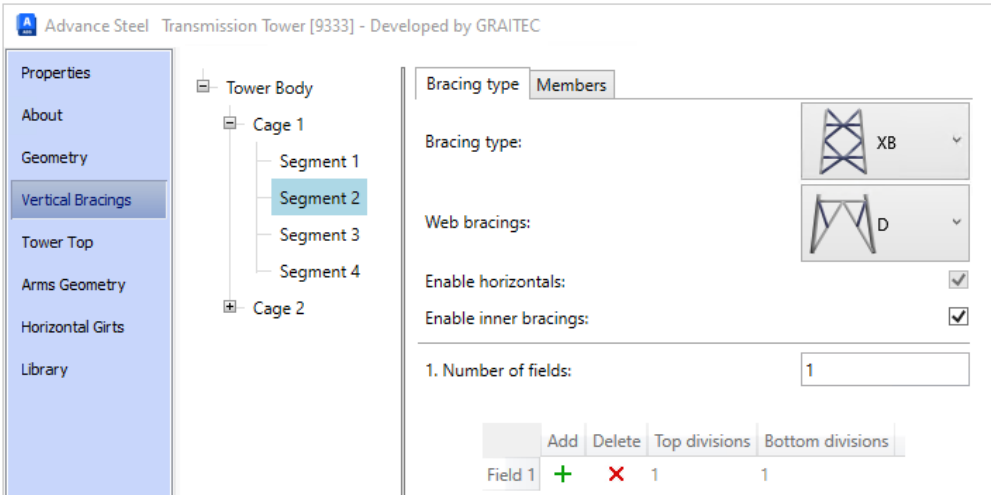
Note: *For number of fields, we will leave this set to 1 for this segment.*



Note: *For the Members Tab we make No changes to the parameters.*

3.1.2 Cage 1> Segment 2

Changing to Cage 1> Segment 2, select this sub-branch of the tree, this then enables the panel tabs to be relative to that level of the macro branching.



3.1.2.1 Sub-Tab: Bracing Type

Under this tab, change the following:

Combo selector: set to **Type XB.**

3.1.2.2 Sub-Tab: Web Bracing

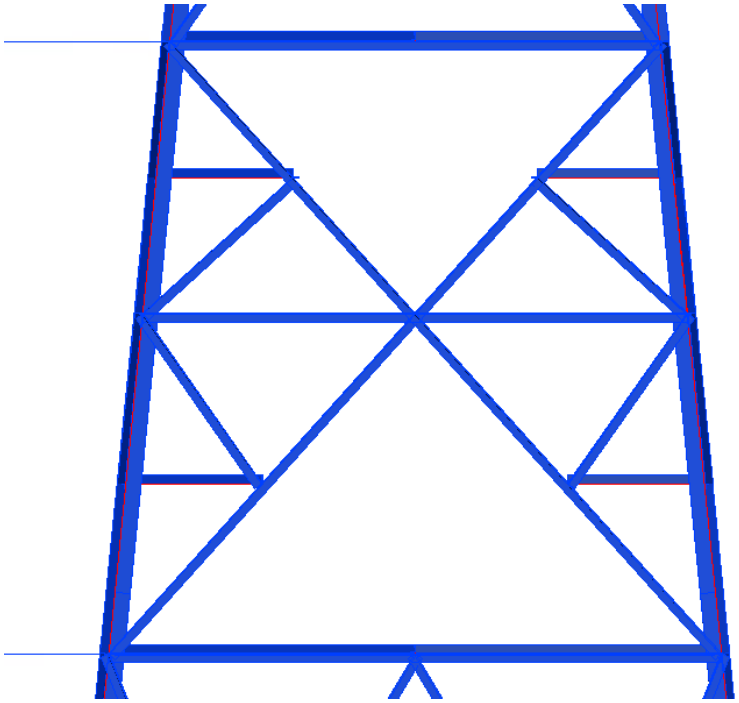
Under this tab, change the following:

Combo selector: set to **Type D.**

3.1.2.3 Check box: Enable horizontals

Check this box to introduce the internal diagonal between the K bracing across the tower faces.

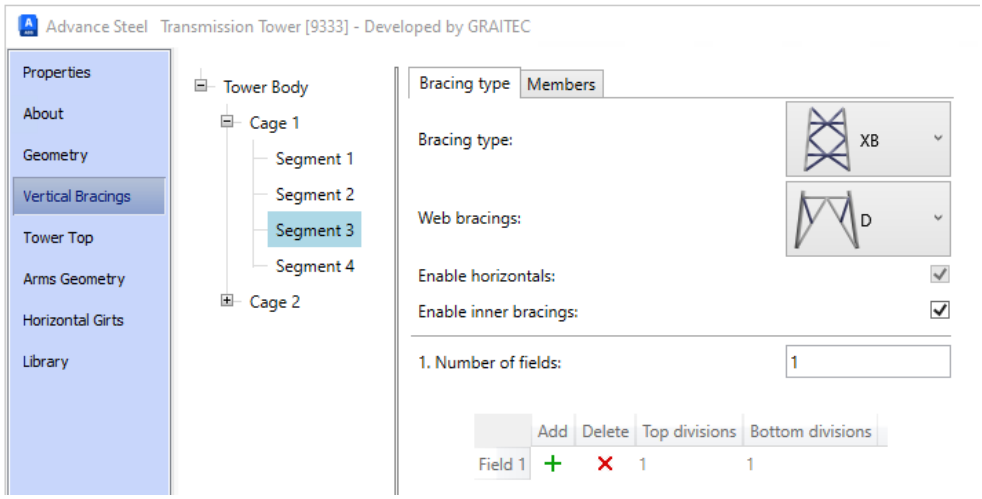
Note: *For the number of fields, we will leave this set to 1 for this segment.*



Note: *For the Members Tab we make No changes to the parameters.*

3.1.3 Cage 1> Segment 3

Changing to Cage 1> Segment 3, select this sub-branch of the tree, this then enables the panel tabs to be relative to that level of the macro branching.



3.1.3.1 Sub-Tab: Bracing Type

Under this tab, change the following:

Combo selector: set to **Type XB.**

3.1.3.2 Sub-Tab: Web Bracing

Under this tab, change the following:

Combo selector: set to **Type D.**

3.1.3.3 Check box: Enable horizontals

Check this box to introduce the internal diagonal between the K bracing across the tower faces.

Note: *For the number of fields, we will leave this set to 1 for this segment.*

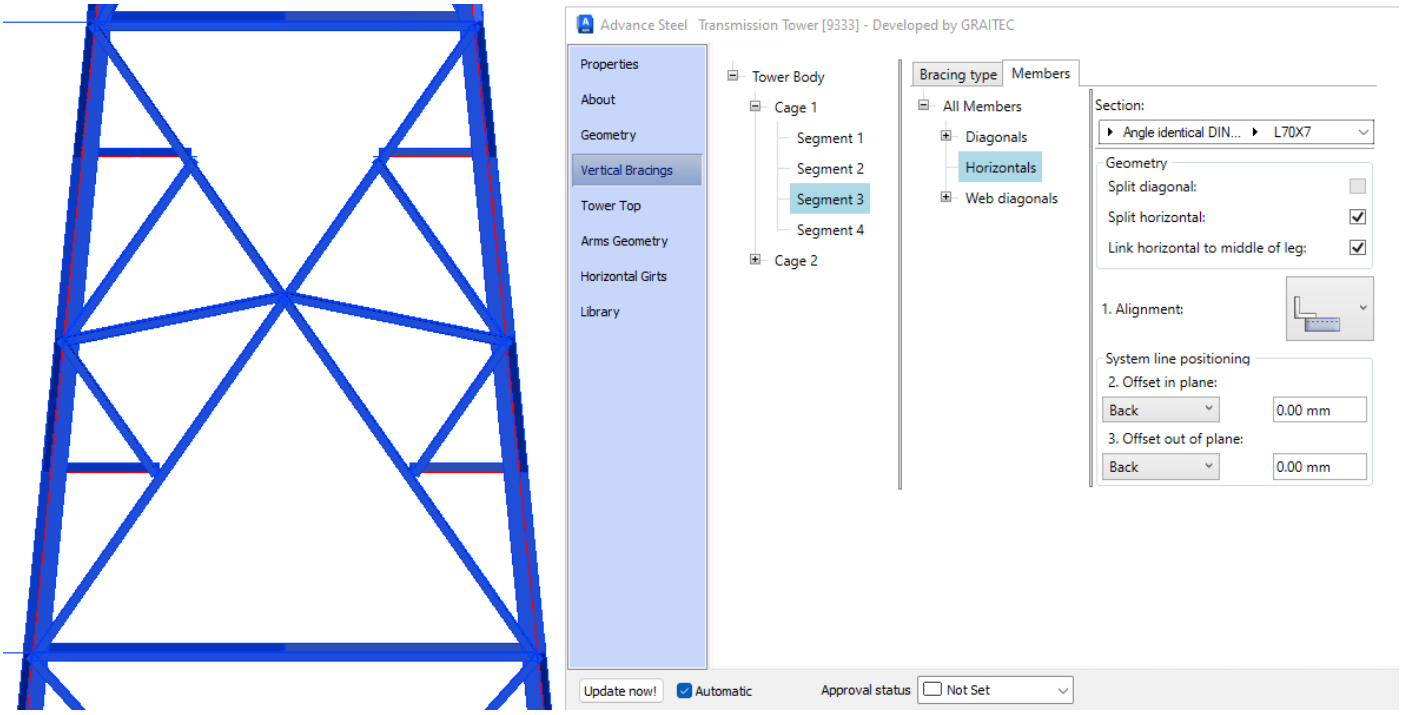
3.1.3.4 Sub-Tab Members

For this segment of the cage, we are going to make some changes in the Members Tab, to allow the splitting and linking to the cage height, for the horizontal members.

Under this tab, we are enabling the check box for the following:

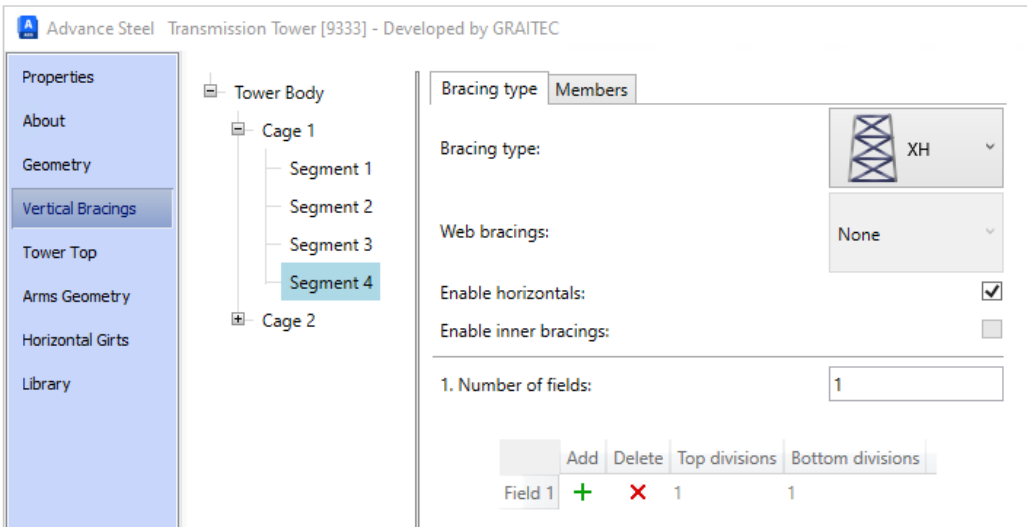
- **Split Horizontal:** check this box.
- **Link Horizontal to middle leg:** Check this box.

This will change the middle horizontally, so it is linked to the inclined main tower legs, at the mid-span point of that segment.



3.1.4 Cage 1> Segment 4

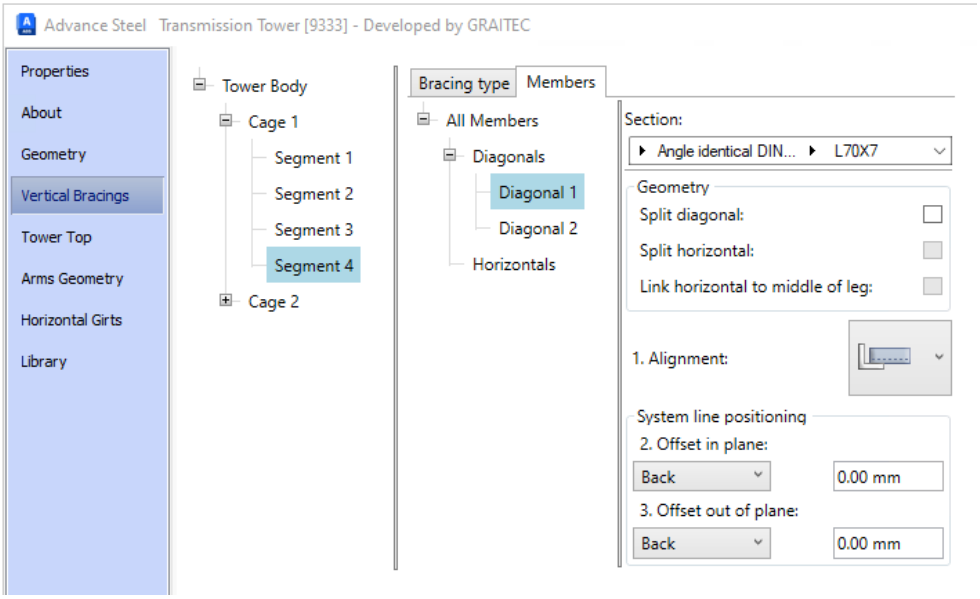
Changing to Cage 1> Segment 4, select this sub-branch of the tree, this then enables the panel tabs to be relative to that level of the macro branching.



For the bracing sub-tab, we are making no changes for this arrangement, but for the members' tab, there are some small changes to highlight the control options over alignment.

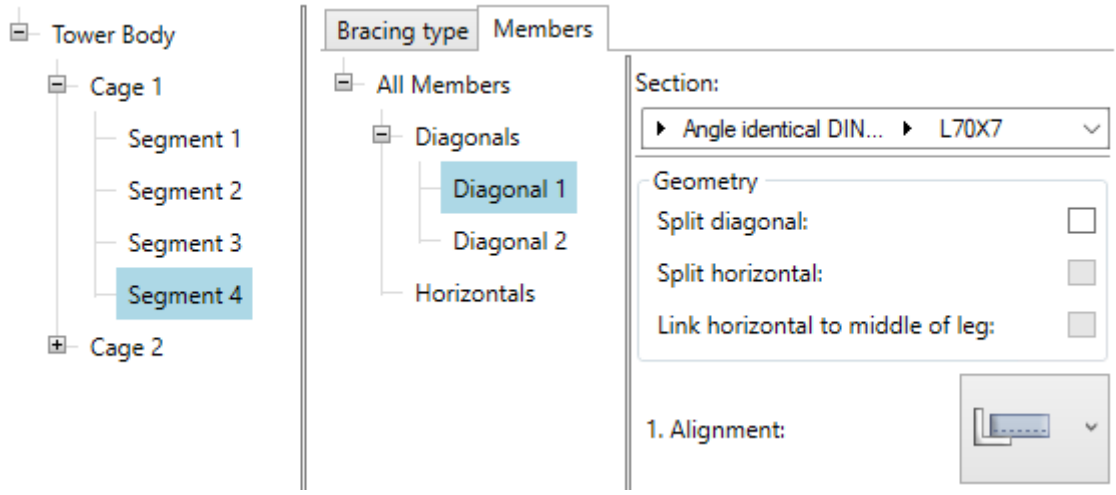
3.1.4.1 Sub tab Members

Changing to this tab, we are going to adjust the alignment of the cross bracing, so one is on the inside of the main legs, with the opposing one on the outer face of the main legs.

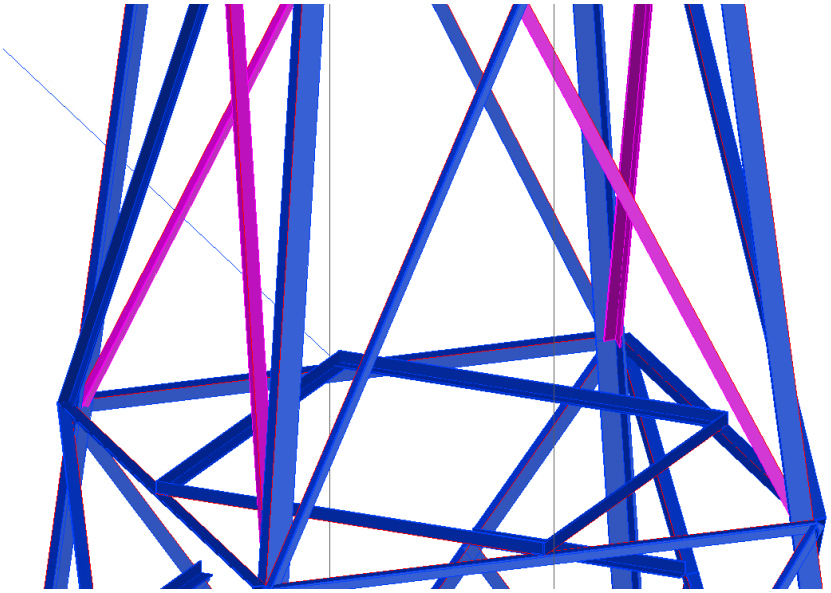


Expanding the Tree for the Diagonals, we can see the two (2) diagonals 1 & 2 branch levels, and under the panel, we can see the *'1.Alignment'* combo selector, this we can adjust to change the alignment to the outer face or inner face.

For this example, we are changing diagonal 1 to inner, and diagonal 2, remains set to the default of outer.



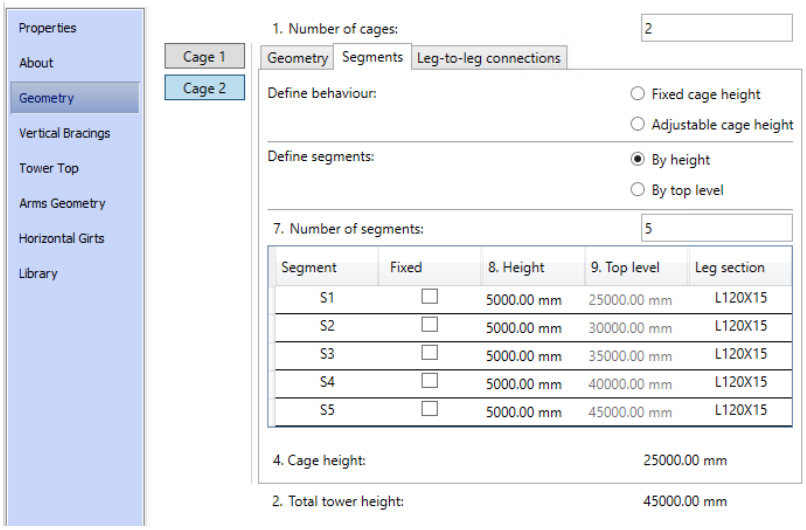
This change results in the cross braces of opposing faces of the tower legs.



3.2 CAGE 2

Moving to Cage 2, where there are five (5) Segments, we are going to explore the options to introduce move Fields within the segments.

The cage 2 segments, we had previously set to 5 no and at equal spacings to keep this walkthrough easy to follow for the user, as they input and create the sample tower.

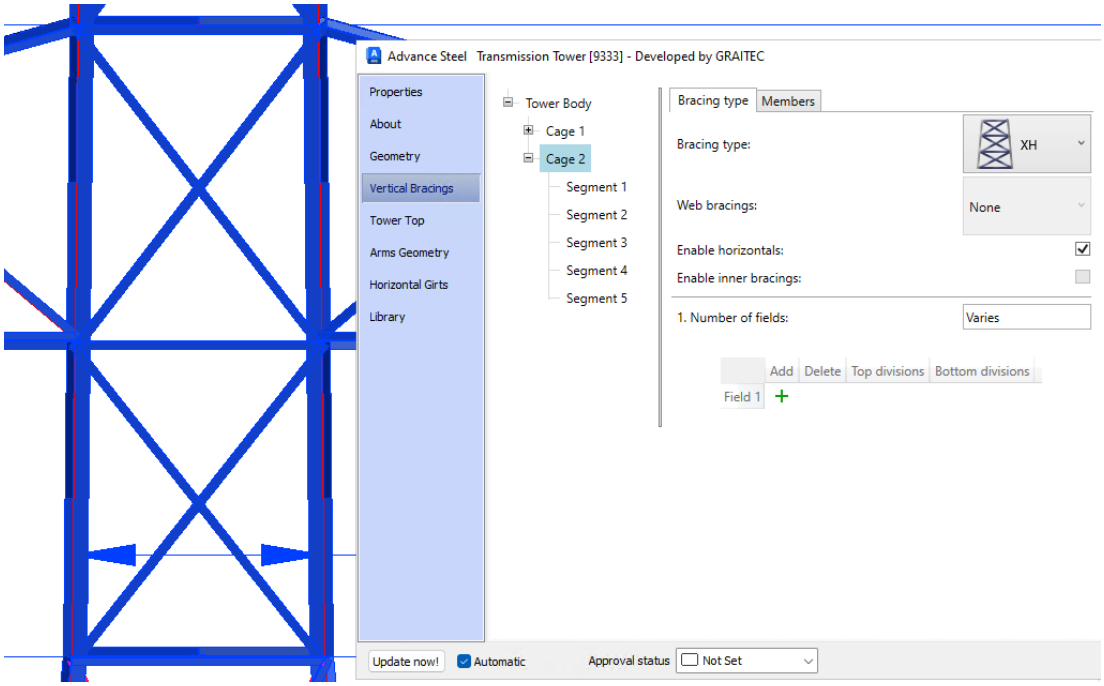


3.2.1 Bracing type for cage 2

For the segments, we are going to set all the bracings to one type for this example, the user may change to any of the subtypes that are present in the macro, as previously outlined in this guide and main help guide.

For this **cage 2 and segments 1-5** we are setting to **Type XH**, but we are going to change the number of fields.

- **Select Cage 2** branch level and then **Set bracing type to XH**.

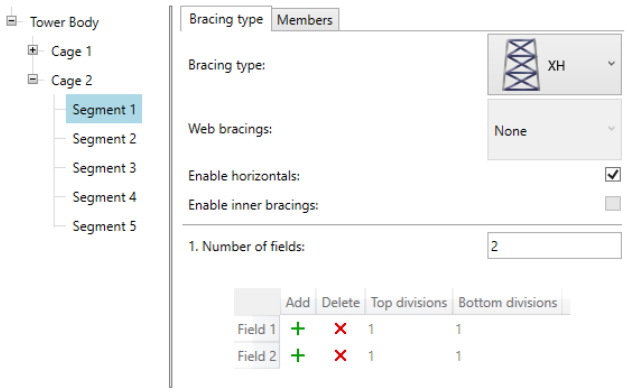


This applies the segments within that cage 2 branch, next we can look at the number of fields within each segment.

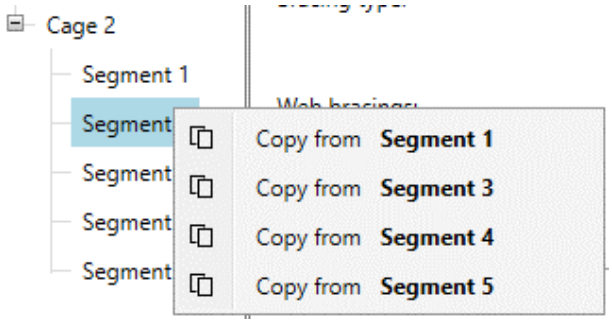
3.2.1.1 Fields: Setting within segments.

Within each segment of the cage, there is part of the panel dialog that refers to fields, this value can be increased as required, from the default of one (1), for this example we will increase Segments 1-4 to have two (2) number fields, with segment 5 increased to Three (3).

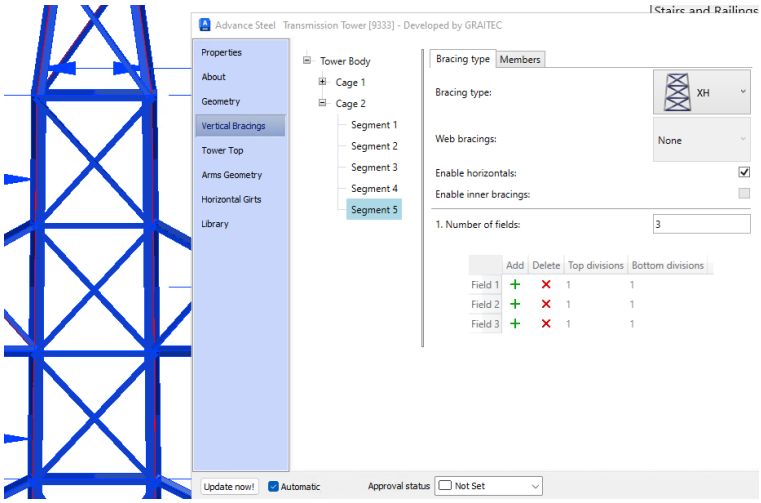
- **Segment 1:** Change **1. Number of fields** to **Two** (2) numbers in the value cell of the dialog. This alters the corresponding table below this parameter entry.



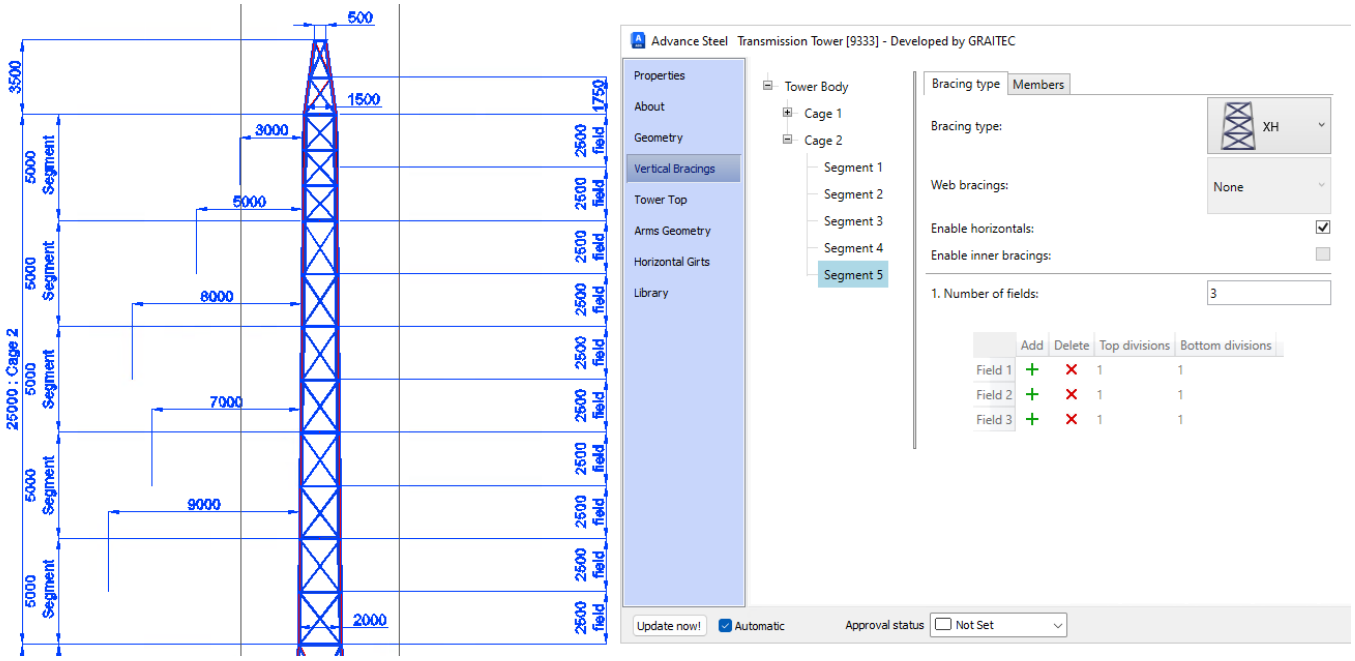
- **Segment 2:** For segment 2, we can use the Copy from option, available under the magic tree part element of the dialog. Selecting '**Segment 2**', to highlight it, then using the **right mouse button**, click to **reveal the contextual menu** options that allow the user to **copy from Segments 1** or other segments.



- **Segments 3-4:** the same approach can be used to copy from segment 1 to segments 3 & 4, or the user can change the number of fields value, if they so wish.
- **Segment 5:** for this segment we are going to introduce a different value, by increasing to 3 number.



In Cage 2, the bracing and fields are now set, which allows for the integration of the Arms into the tower, to follow on in later section in this guide.

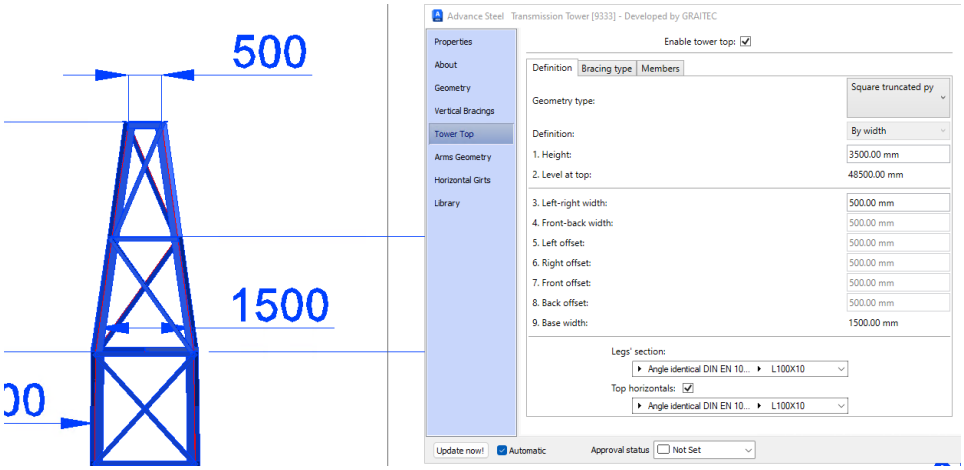


4 TOWER TOP

As we move to the tower top tab, when selecting this the user will need to enable this via the check box, at the top of the dialog, using the check box.

Once enabled the four (4) legs of the top cage are now visible.

The user may change the options to control the size of the tower, height, top width, etc. under the definition tab.



4.1 SUB-TAB: DEFINITION TAB

For this example, we are changing from the defaults, we alter the bracing arrangements and the base starting width is different due to the tower cage 2 below the top cage.

4.2 SUB-TAB: BRACING TYPE

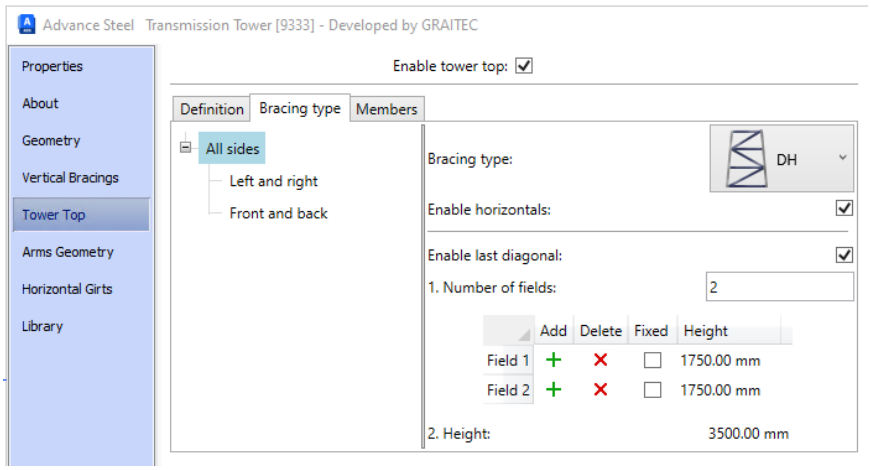
For this tab, we are enabling the bracing arrangement, which is then applied to the fields and the faces of the cage top.

For this tab, there is the magic tree that controls the bracing options to left and right and front and back faces, the bracing schema is activated via the combo selector.

Remaining at the top level of the Tree '*All sides*',

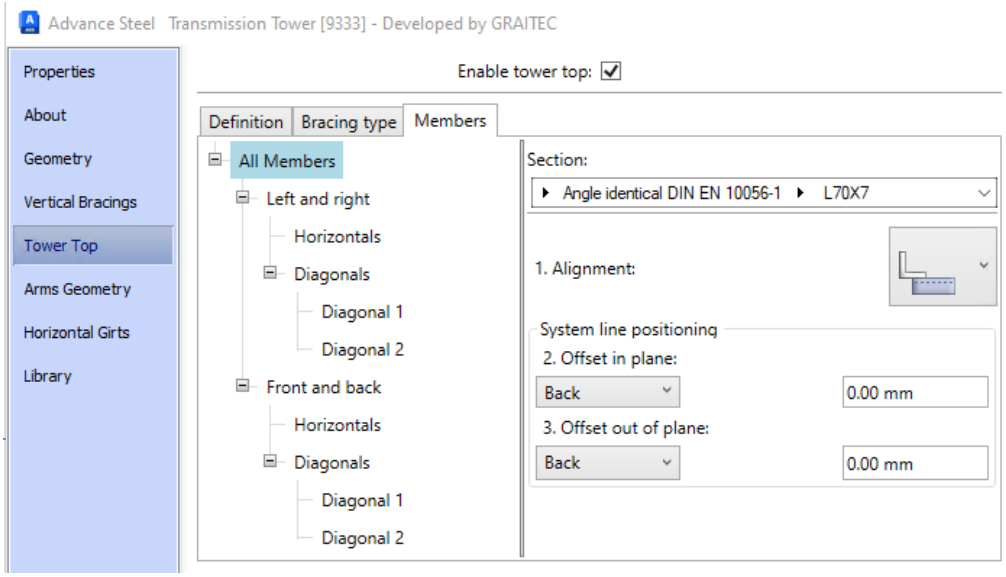
- **Bracing type:** Change to: **DH type**.
- **Enable last diagonal:** check this field to turn on bracing to the top field of the tower top.

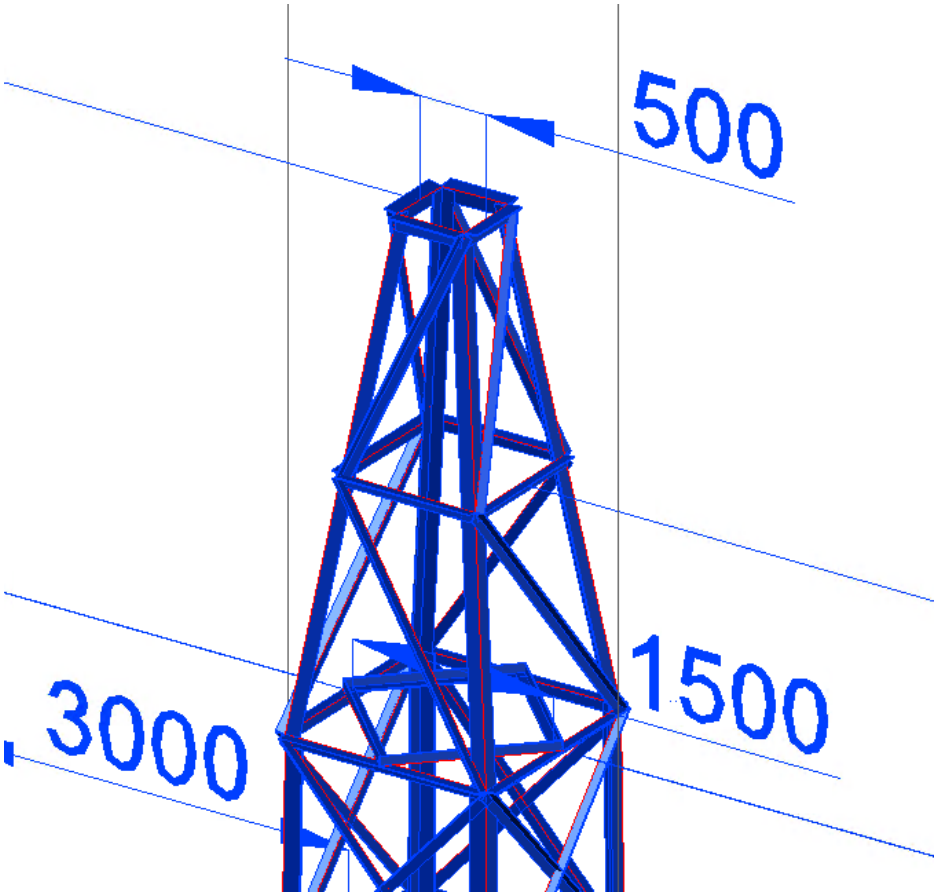
Other parameters and fields, we are leaving as default for this example.



4.3 SUB-TAB: MEMBERS

Although for this example we are making no changes, the user may use this tab to change the alignment and sizes, combined with offsets to influence the final bracing placements.

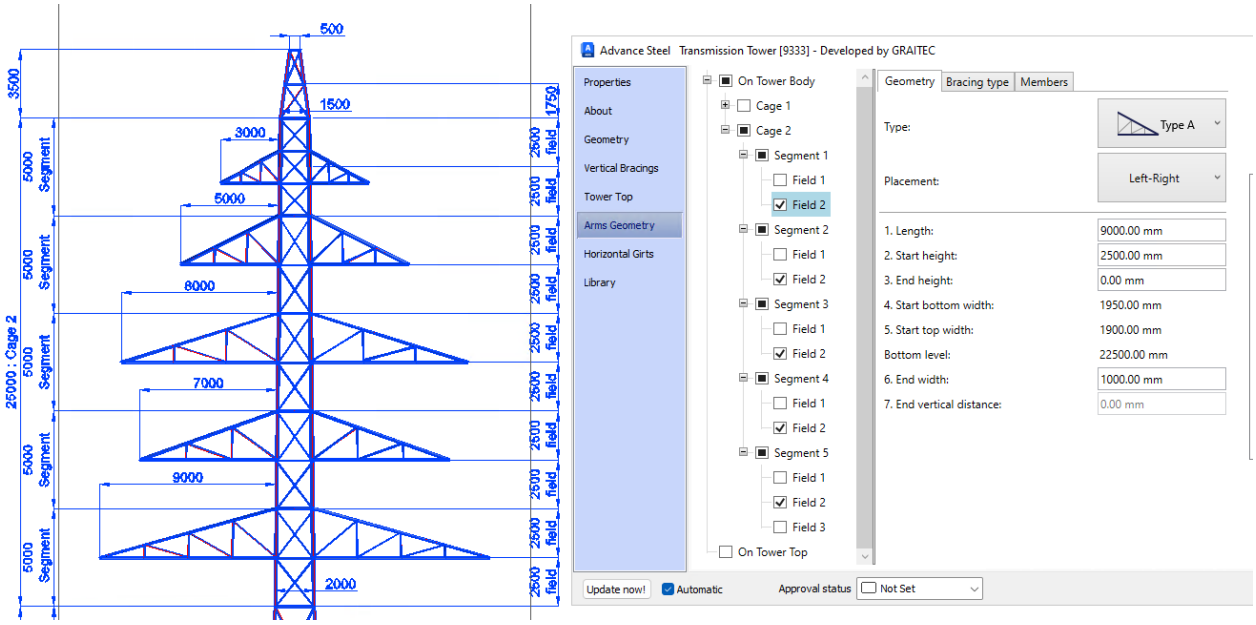




5 ARMS GEOMETRY

As we progress through the macro we now come to the Arms of the tower, the placement and configuration of these arms are controlled within this dialog tab, with the use of the magic tree and a series of sub tabs.

For this example, are going to create a series of arms at the various Fields that we added into the Cage 2 part of the tower, under the segments within that cage.



From the previous image, within each segment, we have enabled a tower arm, of a different span, for this example we have kept the operation to a minimum, to allow the user to find options for arms, if referring to the main Command help guide, there the user can see the different variations available and options to configure, including arms to the tower top cage.

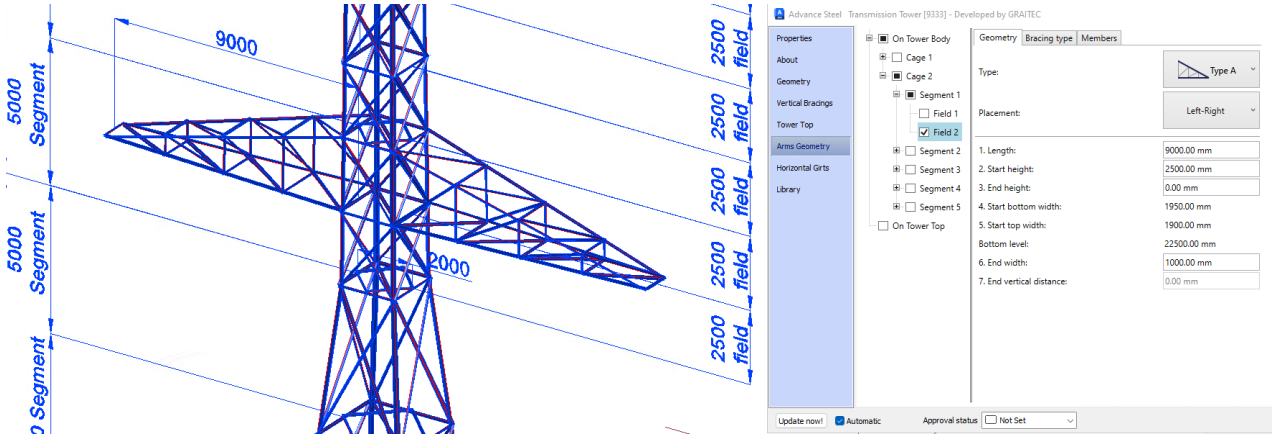
Note: *For Cage 1, we are not adding any arms, only in Cage 2.*

5.1 ARMS>CAGE 2>SEGMENT1>FIELD 2

To activate the Arm in this field, under the segment, the user must select Field 2, under the magic tree and place a checkmark in the box, this will activate the arm to the default configuration.

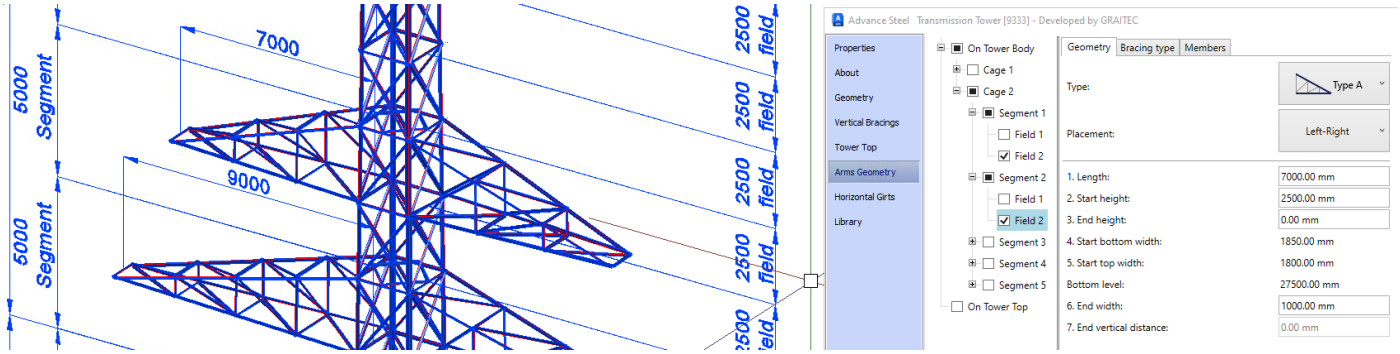
The user can then control the various parameters, under the geometry field, then the bracing arrangements and member size and alignment, as we have seen under other parts of this macro dialog.

For this example: we will set the **1. Length to 9000mm**, and leave the span left to right, with one other adjustment to reduce the end width of the arm, under **6. End width change to 1000mm**.



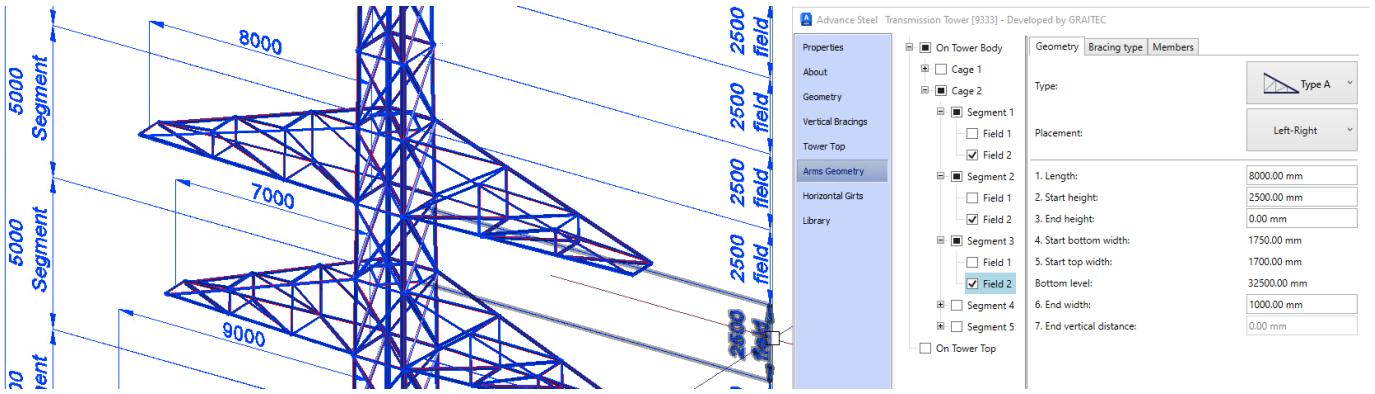
5.2 ARMS>CAGE 2>SEGMENT 2>FIELD 2

To activate the arm within this segment, repeat the same process as before, for this arm the length will be set to **7000mm**, end width **1000mm**, placing this under field 2 of the segment.



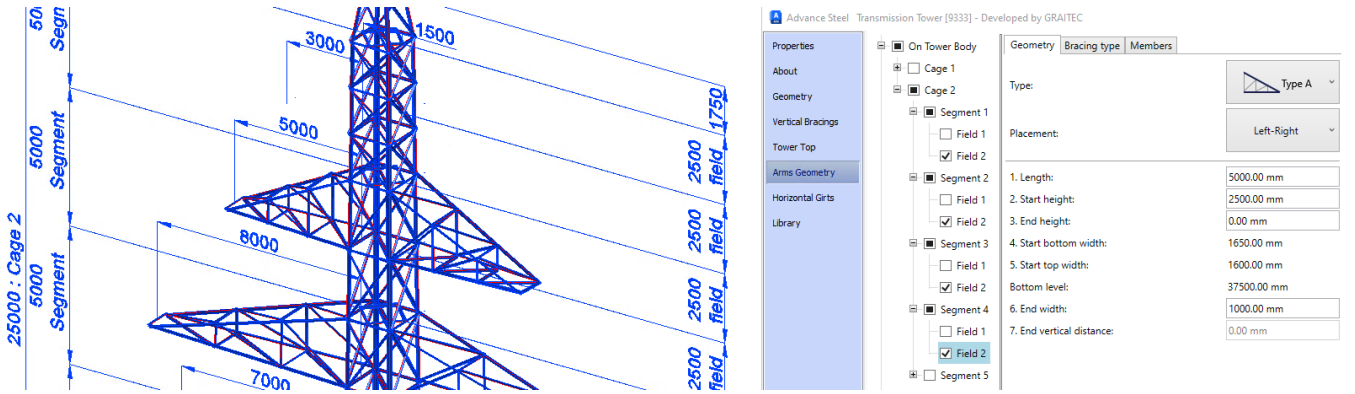
5.3 ARMS>CAGE 2>SEGMENT 3>FIELD 2

To activate the arm within this segment, repeat the same process as before, for this arm the length will be set to **8000mm**, end width **1000mm**, placing this under field 2 of the segment.



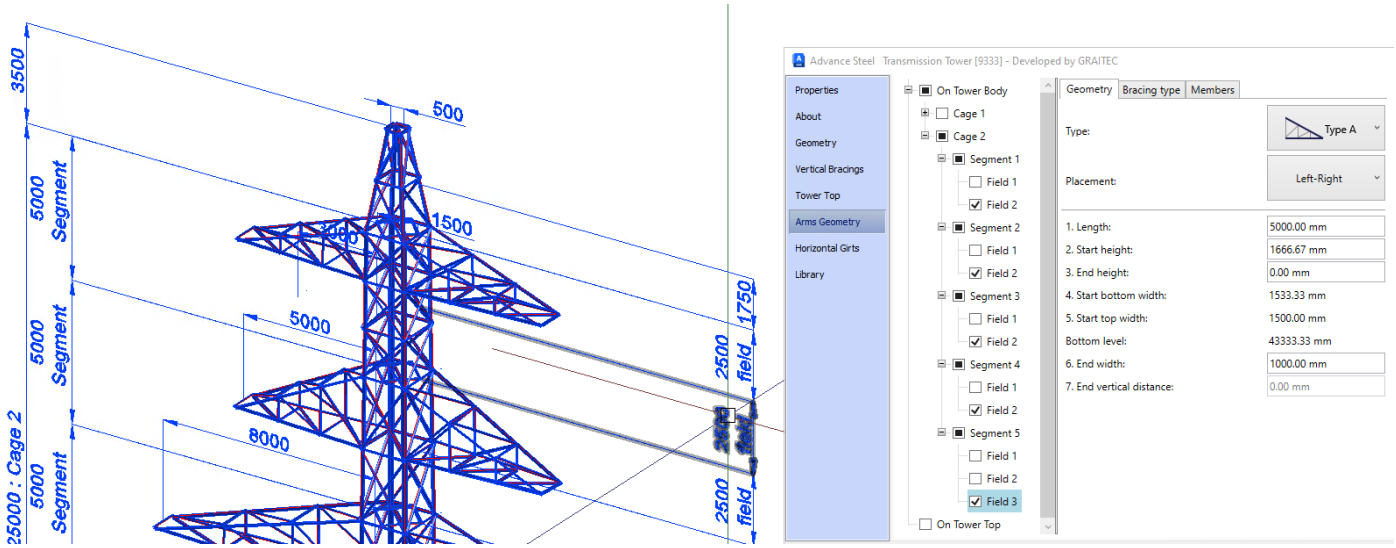
5.4 ARMS>CAGE 2>SEGMENT 4>FIELD 2

To activate the arm within this segment, repeat the same process as before, for this arm the length will be set to **5000mm**, end width 1**000mm**, placing this under field 2 of segment 4.



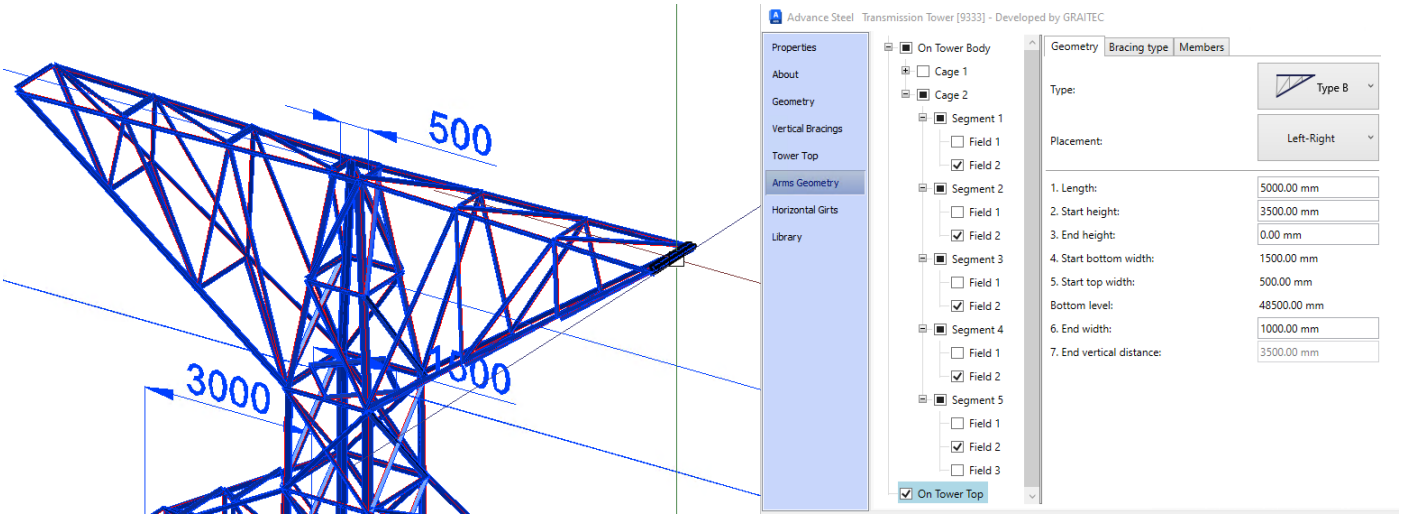
5.5 ARMS>CAGE 2>SEGMENT 5>FIELD 2

To activate the arm within this segment, repeat the same process as before, for this arm the length will be set to **3000mm**, end width **1000mm**, placing this under field 2 of the segment 5.



5.6 ARMS>CAGE 2>SEGMENT 5>TOWER TOP

To activate the arm within the tower top cage, there is a final check box for this, checking this will activate the arm elements within the top cage of the tower, sample of this is shown below:



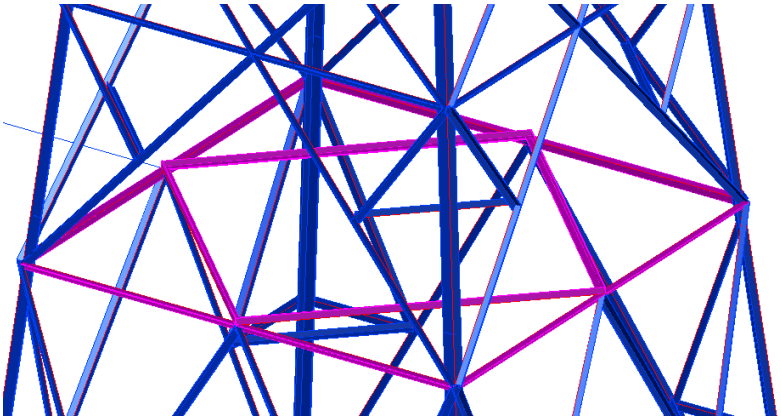
6 HORIZONTAL GIRTS

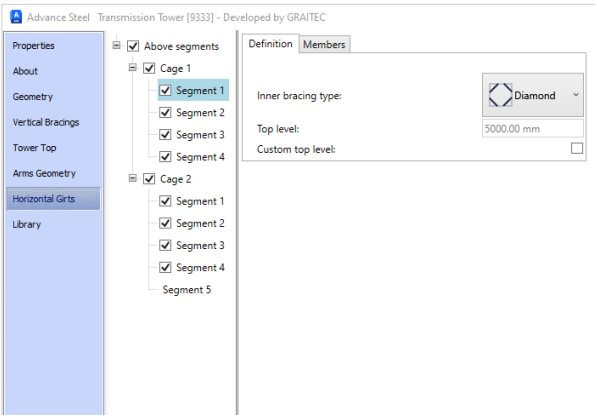
Within the macro, as we have progressed, there has been a series of horizontal inserted into the towers, typically at each top of segment level, these are referred to as the Horizontal girts.

Their arrangement and pattern are controlled in the tab of the same name, via the use of the magic tree to control them at each segment level within the overall tree.

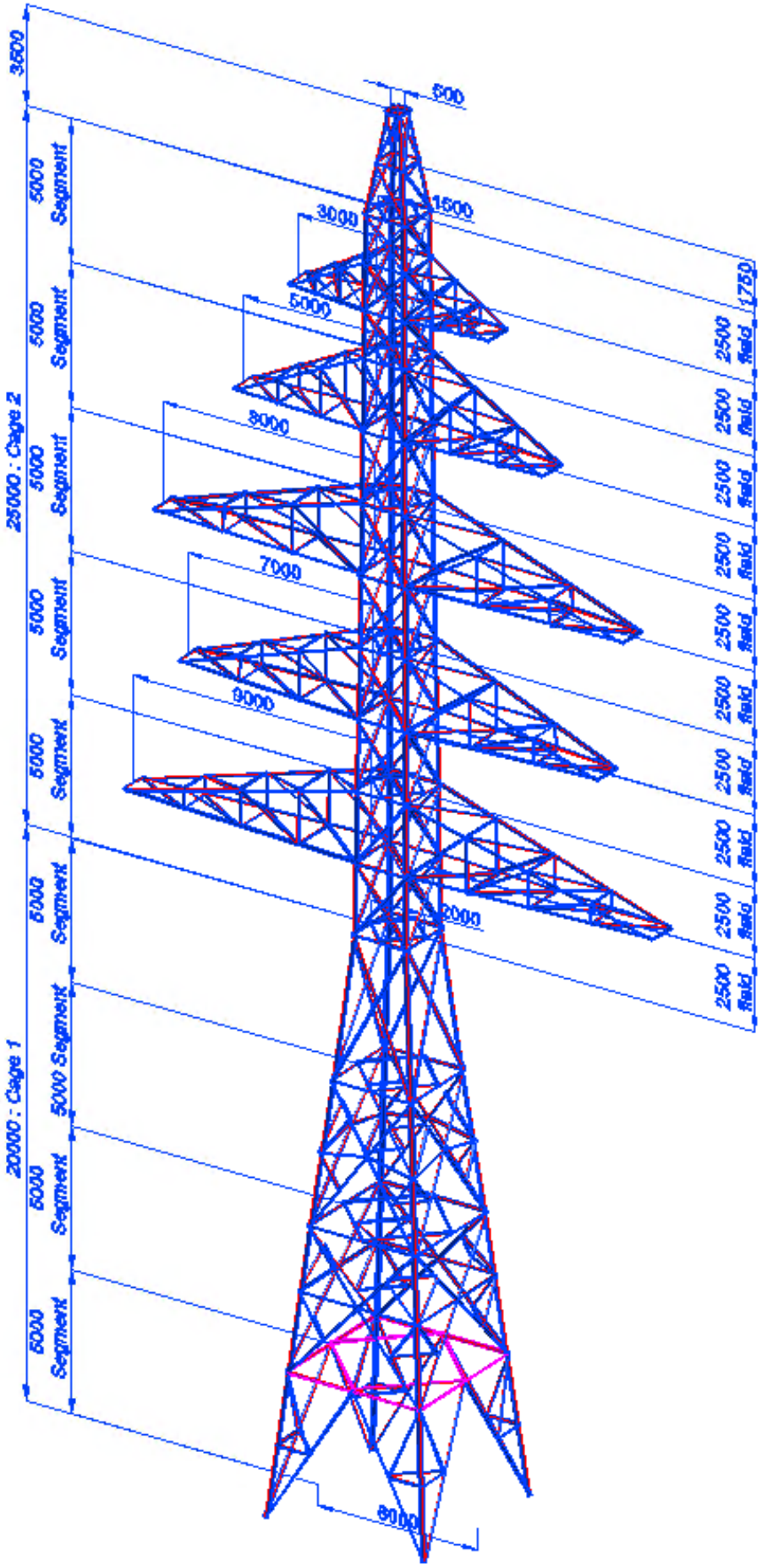
The pattern can be changed under the definition tab, this is outlined in the main command help/guide.

We do not plan to make any changes in this example, but just to note to the user, that they may choose a different schema at this location within the overall tower.





This concludes this introduction walkthrough to the basics of the Transmission tower. There are many options and parameters, to achieve multiple arrangements. Please continue to experiment and learn whilst exploring this macro.


3500
500
1500
3000
5000
8000
7000
9000
2000
8000
25000 : Cage 2
20000 : Cage 1
5000 Segment
6000 Segment
2500 field
1750